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The Future of Surgery

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FROM TIME TO TIME predictions about the future of surgery have been made that subsequently proved to be both fallible and foolish. Indeed, most such predictions now serve the classic purpose of indicating the folly of those who made them. Obviously, too, they serve as a warning to those who may be tempted or, as in my case, may be requested to prophesy about the future of surgery. Prudence demands that I heed this warning, and rather than engage in the forecasting of future events in surgery, I should like to consider some of the broader progressive developments in surgery; to characterize the features underlying this movement, particularly in American surgery; and to indicate certain emerging trends and factors that may greatly influence its destiny.

Throughout recorded history and largely reflecting the status of social and intellectual developments of the times, surgery has played a role of varying efficacy and stature. In the past half century, however, it has made greater progress than in all previous times. Indeed, the growth of surgery has been so progressive and its scope so broadened that it may rightfully be considered one of the most rapidly advancing fields of medical scientific endeavor.

To appreciate fully the great advances that have been made in surgery during this span of five or six decades, one need only contrast current surgical developments with the status of surgical thought about the turn of this century. Although by 1900 the full impact of the two most revolutionary discoveries in surgery, anesthesia and asepsis, had become evident in the vast expansion of surgical technology, the limited knowledge of that day restricted its extension to certain areas of the body, and some, like the chest or the cardiovascular system, remained unassailable. The lag in application of technologic advances to lesions of these organs and systems was due primarily to deficient knowledge of cardiorespiratory and other physiologic functions and to inadquate and imprecise diagnostic methods and facilities. Surgical conquest of diseases of these organs and systems, as was indicated by Churchill,[1] required more precise delineation of localized disease than was afforded by the stethoscope. In addition, the art of anesthesia required extension of its scope beyond simple obliteration of pain to include maintenance of life-supporting oxygenation and circulation. The solution of these major problems came first with the discovery of the x-ray by Roentgen, in 1895, and, much later, its subsequent refinements to include the use of opaque media, and second with the development shortly after the turn of the century of an effective means for maintaining anesthesia and oxygenation in the presence of an open pneumothorax.

There remained, however, other major barriers to the effective use of surgical principles against many of these grave diseases. Most important among these were first, the occurrence of shock resulting from loss of blood during the operative procedures, and second, the occurrence of invasive infection.

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The former obstacle was overcome by the development of blood transfusion derived from the discovery of blood groups by Landsteiner, in 1900, and subsequently, of methods to permit the preservation and storage of blood. The latter problem was largely solved within the past few decades with the discovery of chemotherapy and, in particular, antibiotics.

Thus, with these major fundamental achievements, that is, development of more adequate diagnostic facilities by roentgenography to permit precise localization of disease, development of effective means for maintaining anesthesia and oxygenation, provision for the ready utilization of blood transfusion for the prevention of shock from blood loss, and the discovery of effective chemotherapeutic agents and antibiotics for the control of invasive infection, the way was open for the surgical conquest of many diseases that previously were unassailable.

The profound influence of these fundamental developments is further reflected in the striking change in emphasis and point of view that has taken place in surgery during this half century. Indeed, certain topics that occupied much interest and attention in earlier years have virtually disappeared with the phenomenal growth and development of new fields of surgery, such as those concerned with the heart and blood vessels. During the first few decades after the turn of this century, for example, considerable attention was devoted to asepsis and antisepsis, postoperative complications, infections, and gangrene. More recently, on the other hand, these topics have been displaced by a change in emphasis from these *pathologic interventions* and studies in morbid anatomy to investigations dealing with basic metabolic disturbances induced by surgery, as well as those produced by disease. Fluid and electrolyte changes and other underlying physiologic and biochemical disturbances produced by the stress of surgical procedures have come to the fore within recent years. This impressive shift in emphasis has also brought about a change in the aims of surgery, which previously were concerned largely with extirpation of diseased organs and repair of trauma. Now emphasis is placed upon preservation and restoration of normal function, as well as the cure or obliteration of disease.

This change in emphasis characterizing the nature and goals of modern surgery, particularly American surgery, is well illustrated by the phenomenal progress that has taken place in the field of cardiovascular surgery during the past decade and a half. Indeed, the advancements made during this short period far surpass all previous efforts in this field of surgery. This is exemplified by the development of effective surgical treatment for diseases of the aorta and its major branches, such as aneurysms and occlusive lesions. Aneurysms of the aorta, for example, have challenged physicians for centuries, having been recognized as a deadly condition since earliest times. Various methods of treatment were devised and employed, but none proved effective until recently. Within the past decade, curative therapy was accomplished by development of the surgical procedure of removal of the diseased segment of the vessel and replacement with a synthetic vessel to restore normal circulation. Successful application of this method of treatment is dependent upon a number of factors, among the most important of which are the principles of blood vessel suture and arterial graft replacement, as well as control of certain hemodynamic disturbances incident to this intricate procedure. The development and refinement of these principles were brought to full clinical fruition in the research laboratory, thus providing another impressive characterization of modern American surgery. Of passing interest in this connection is the fact that many of the underlying technological principles of this method of treatment were

well developed by experimental workers and were even applied sporadically by a few surgeons more than half a century ago. One might well ask why, then, should there have been this long lag in the successful clinical application of these well-established technical principles of surgery. The answer to this question probably lies in consideration of a number of factors, some of which have an important bearing upon the general movement of medicine and surgical thought. For one thing, certain ancillary measures in surgery, including, particularly, anesthesia, blood transfusion and chemotherapy, had not been developed adequately to support extensive surgery of this type, and the precise diagnostic procedure of angiography was not available to delineate its proper application. For another, the general status of surgical endeavor had not matured sufficiently to accept this more vigorous and aggressive approach to these difficult and complex surgical problems.

Thus, within the past decade curative treatment of aneurysmal disease has become a complete reality with widespread application. The centuries-old challenge has been successfully met. So rapid and effective have been these developments that it can now be stated that effective surgical treatment is available for all forms of aneurysmal lesions of the aorta and its major branches, no matter what may be their extent or location.

Equally striking has been the progress made in recent years both in a better understanding of the nature of arterial occlusive disease and in the development of precise methods of diagnosis and effective therapy. The importance and gravity of this widespread disease, which is primarily due to arteriosclerosis, has long been recognized, since it is by far the most common cause of death and disability. Although the precise etiology of this disease remains a baffling problem, intensive research and clinical investigations during the past decade, largely through surgical endeavors, have established an important concept of the disease which has led to highly effective methods of surgical treatment. Particularly significant have been the changing conceptual developments which have placed emphasis upon the fact that the major problem is concerned with the hemodynamic disturbances produced by the occlusive process, no matter what the etiology may be, and that the primary objective of therapy is correction of these disturbances by restoration of normal circulation. Thus, the concept has evolved that the lesion in many forms of occlusive diseases, and especially in those of arteriosclerotic origin, may be well localized and segmental in nature with relatively normal arteries both proximal and distal to the occlusive process. Moreover, through investigations derived largely from arteriographic and surgical experiences, it has now been demonstrated that this characteristic pathologic feature of the disease tends to assume segmental occlusive involvement in certain parts of the aorta and its major branches resulting in typical clinical patterns of vascular insufficiency. These include, particularly, the major branches of the aortic arch, the visceral branches of the abdominal aorta, and the terminal abdominal aorta and its major branches to the lower extremities. The great significance of this important concept of occlusive disease lies in the fact that it has provided the basis for the development and application of corrective surgical methods of therapy designed to restore normal circulation and thus overcome the hemodynamic and ischemic effects of the occlusive process.

No less impressive have been the brilliant advances made in recent years in surgery of the heart. Although a few pioneering efforts in cardiac surgery were made during the first few decades after the turn of the century, they were limited, for the most part, to traumatic and extracardiac conditions. Most of the important

developments have occurred only during the past decade. Although at first the scope of operative procedures was limited by the fact that maintenance of cardiopulmonary function was vital during intracardiac manipulations, recently this obstacle was overcome with the introduction of a method to provide direct and full exposure of all chambers of the heart and thus to permit application of corrective surgical procedures to various forms of intracardiac lesions. This new field of open heart surgery was made possible by the development, through intensive surgical laboratory research, of mechanical devices to substitute temporarily for the vital functions of the heart and lungs. The pump oxygenator, as it is generally known, is now in widespread use in most medical centers, and thousands of operations using some modification of this device have already been performed. Whereas less than ten years ago only a selected few cases of congenital cardiac diseases were amenable to surgical correction, today the majority of cardiac anomalies are completely correctable. Considerable progress along these lines has also been made in the surgical attack upon acquired lesions of the heart, and efforts to develop synthetic substitutes for diseased heart valves are being vigorously pursued and are meeting with increasing success.

It is thus apparent that truly impressive progress has taken place in the field of surgery in the relatively short span of a few decades. Among the most striking features of these advances, and undoubtedly important factors underlying their attainment, have been the increasing intensity of research endeavors and the bold ingenuity and aggressive approach characterizing the surgical attack on these grave diseases. No less important has been the fact that these surgical investigations have contributed significantly to greater knowledge and better understanding of the fundamental factors involved in the pathologic, physiologic, and biochemical disturbances of vital body functions. Indeed, the intensified activity in the surgical research laboratories, which underlies most of these progressive developments, constitutes in many respects one of the most outstanding characteristics of modern American surgery.

This is readily apparent in the increasing trend to provide closer integration of clinical work in the hospital wards and operating room with investigations in the experimental laboratory. Studies in the laboratory may be inspired by certain clinical problems encountered on the wards or in the operating room, by new developments in technic, apparatus, and instrumentation, or by new ideas or working hypotheses derived from other scientific disciplines. Whatever the source may be, such lines of development arouse immediate interest and attention concerning their potential clinical significance and the possibility that they may provide solutions to clinical problems or may represent a true *breakthrough*. This is well exemplified by the current trend of increasing surgical interest and activity in the field of tissue transplantation. Many of the significant studies and observations in this area are being made by geneticists, immunologists, biochemists, and biologists. Sensing their potential clinical significance and recognizing the tremendous impact on surgery that a breakthrough in this field would provide, an increasing number of surgeons have joined their colleagues in the fields of basic science in directing their energies toward this area of endeavor.

This vigorous characteristic of present day surgery was well identified and eloquently developed by Churchill [1] who considered it "the most significant feature of twentieth-century surgery" which has rapidly been gaining headway, particularly during the past two decades. "It is a trend," he stated, "that cultivates the discipline of the mind that is needed to complement and guide surgical technology. It is a trend

that re-establishes the surgeon as a biologist and as a physician in the broad sense of one skilled in the healing art. It is a trend that breaks down the sterile isolation of the surgeon at the operating table and encourages him to travel in company with others—with the internist, the physiologist, and the chemist—in a common quest for the clarification of unsolved problems."

The strong and rapid emergence of this trend in surgery, particularly during the past few decades, the impetus it has now gained, and its striking clinical achievements, bear considerable significance upon the future movement of surgery. As emphasized by Churchill, this trend "is not in conflict with a sound and competent technology, nor is it incompatible with the maintenance of the humanitarian qualities that are treasured so highly by responsible members of a great profession." Indeed, I believe that it will help to further these objectives. Historically, and by the very nature of the healing art which he practices, the surgeon must remain in close and constant touch with the patient and his disease.

A final but important characterization of modern surgery which has considerable bearing upon the future of surgery is concerned with training and education. This has undoubtedly provided one of the most profound influences upon the general advancement of surgery as well as upon the elevation of the standards of surgery being practiced across the country. It began about the turn of this century with the introduction of the surgical residency system which is based upon the principle of intensified progressive training in the fundamental as well as the technical, aspects of surgery. This surgical training program has been highly developed and refined during the last few decades to provide carefully supervised training in the clinical practice of surgery with graded responsibility in the surgical care of patients. While there has been some concern that it may have become too formalized, in most teaching or university hospitals it has remained sufficiently flexible to encourage the academic inclinations of young surgeons. But this is a matter that deserves careful consideration since the future of surgery is dependent, in large measure, upon the quality and capacity of the individuals attracted into this field of endeavor, as well as upon the nature of the training program. Of particular importance in this connection is the fact that from this group will be selected those who wish to remain in an academic atmosphere and devote their interest and energies primarily to the investigative and teaching aspects of surgery, and so will ultimately affect future development.

It is obvious, therefore, that this is a matter of great importance and that certain factors which may influence its course and development deserve serious consideration. Some of these factors have become increasingly apparent, while others are only dimly outlined at present, since they are dependent upon the needs and dictates of society itself. Among these, one, which is assuming increasing importance, is concerned with the source of clinical material for surgical training. Since the training for surgery is intimately related to the practice of surgery, the surgical patient is an absolutely essential ingredient of the training program. In the past, teaching patients were derived from the indigent segment of the population and there was no dearth of such clinical material. But now our society has clearly indicated its desire to eliminate medical indigency and is pursuing a course toward this objective through various types of health insurance programs and is giving increasing consideration to other programs, such as the social security plan.

This development has created certain problems resulting primarily from the fact that the conversion of an indigent to a nonindigent patient by these means is associated with recompense for professional

services. The first, and perhaps the greatest, of these problems is concerned with the formulation of a method to integrate these patients, who are now able, by one means or another, to pay a fee for service and who may thus be classified as private patients, into a well organized clinical teaching and research program. Secondly, an equitable method of utilizing and disbursing the professional fees derived from services rendered such patients must be devised. There now exists a dichotomy of thought about these problems within both the university or teaching hospital faculty and among members of the medical profession at large. On the one hand, there are those who hold strongly to the traditional point of view that a patient who is able to pay a fee for service, no matter what the source may be, must become the private patient of an individual physician who should receive this fee for service as proper recompense for the performance of his service. This conviction is held so strongly by some that it is rationalized as a violation of ethical principles to do otherwise. On the other hand, there are those who believe that such patients can be provided equally good, if not better, medical care within a well organized or so-called group practice program, whether it be in a university or non-university teaching hospital, without regard to individual compensability on a fee for service basis.

Our major concern with this problem and these diametrically-opposed points of view is not so much with its economic implications but with its profound effects upon surgical training and upon educational programs and research endeavors. If, for example, the former point of view prevails, these educational and research activities are bound to be severely handicapped. Obviously, a rapid and proper solution to this problem must be found. Since this matter is so intimately related to certain academic obligations, any solution to this problem must take into consideration the primary function of the medical school and the responsibilities of its faculty members who are engaged in these educational and research activities. In this connection, this problem exists both for the medical school and its teaching hospital and for the well organized teaching hospital without university affiliation. The three major functions of a medical school; namely, teaching, research, and medical care, have long been recognized and accepted. To be sure, each of these functions is essential to the objective of the institution. In actual fact, however, the primary function is teaching. But in order to perform this function the institution must engage in medical care. In like manner, research becomes a desirable and, indeed, essential activity for two reasons—to improve medical care and teaching and to meet the academic responsibility of the university to advance knowledge. Medical care thus becomes as essential an ingredient of the teaching activity of the institution as the laboratory work in the departments of physiology or biochemistry. Accordingly, it may be postulated that the faculty member engaged in this activity in a medical school or teaching hospital is simply performing this function for its primary purpose of teaching and clinical investigation, not for the purpose of compensation. To be sure, the fee for service is available as compensation but only because the patient is capable of providing it. Thus, compensability, in this sense, is not an essential component of the medical care-teaching function of the faculty member and should not be used as a criterion for distinguishing his function from that of other non-clinical faculty members. Acceptance of this point of view, which places emphasis upon the academic responsibilities of the clinician in a university or teaching hospital structure, can provide the basis for resolution of the problems created by the compensable factor in the utilization of this increasingly necessary source of

clinical material for teaching and research purposes.

With a proper understanding of the spirit and nature of university medicine and the academic obligations it entails, it becomes possible to develop an effective organization to achieve the purposes of a surgical training program involving medical care and clinical investigation of high quality, utilizing patients capable, by one means or another, of paying a fee for service. To be sure, certain changes and adaptations will be required in the current organization, directed toward a better integration of the residents as responsible members of the clinical team of surgeons. At the same time, however, proper supervision and assignment of graded responsibility in accordance with the training and experience of these junior members of the surgical team can be maintained.

Disbursement of funds derived from provision of medical care under such an organizational structure should not constitute a great problem. For one thing, they should be considered as proper compensation for services rendered. For another, there should be an equitable allotment to provide adequate compensation for all those engaged in this activity, as well as to further their academic obligations. In this connection, it must be realized that proper medical care is becoming increasingly complex, often requiring the professional services of a large team of physicians and surgeons, no one of whom may be singled out as earning the entire, or even the major portion, of the fee for services rendered.

In summation, it would appear that the most impressive characterization of modern surgery, particularly American surgery, is the increasing trend to integrate more closely investigative studies with clinical activities. This growing interest in surgical research, particularly in application of knowledge gained from the basic sciences, represents an attempt to provide a better understanding of the underlying physiologic, biochemical, and metabolic disturbances of the body produced by the stress of surgical procedures, as well as by disease and injury. Technics and research methodology derived from the basic sciences, such as the use of isotopes and complex electronic instrumentation are being used with increasing frequency by the modern surgeon in his effort to learn more about physiologic functions and vital cellular mechanisms. This, in turn, has resulted in a shift in emphasis in the aims of surgery from the simple removal of diseased tissue and repair of trauma to the preservation and restoration of normal function and the cure of disease. These changing developments along with the vigor and increasing intensity of research endeavors and the bold ingenuity and aggressive approach characterizing the status of current surgery not only assure its continued progress, but also portend advances of even greater importance than those made in recent years. Accompanying these developments are the rapid advances being made in the broad field of science from which surgeons will derive further support in their quest to apply their art more effectively. Finally, certain economic and social developments must now be recognized as influential factors in the changing pattern of medical care and particularly in the training and education of surgeons. With confidence in the traditionally practical and decisive nature of the surgeon and his teaching responsibilities, we may rest assured that he will fully meet this momentous challenge.

Reference

1. Churchill, E. D.: Medicine as a Science: Surgery. New Engl. J. Med., 244:799, 1951.